Steudener (F.)

VEGETABLE ORGANISMS

AS

CAUSES OF DISEASE.

Bind cover in front

By DR. F. STEUDENER.

TRANSLATED FROM THE GERMAN

By CONRAD GEORG, M. D.

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VEGETABLE ORGANISMS

AS

CAUSES OF DISEASE.

BY F. STEUDENER.

Translated from the German by CONRAD GEORG, M. D.

During the last years, medical investigation has cultivated, with a certain degree of predilection, the field of the etiology of diseases; and the question pertaining to the nature of the substances, which must be accepted as the causes of the infectious diseases, and are designated as contagion or miasm, has especially called forth numerous investigations. As is well known, the ideas entertained of them by the physicians, in regard to the art and manner of their influence on the organism, have changed often in the course of time. In the last years, the view has gained ground, that in these diseases there is a fermenting

process going on in the system, and the infectious diseases have since been generally designated zymotic diseases. Although the theory of zymosis is, at present, void of all real foundation, still it cannot be disregarded, since the latest investigations of the fermenting processes have shown them in clear light, that there exists a certain degree of analogy between the so-called zymotic diseases, and the fermenting processes, that the multiplication and reproduction of the causes of disease in the system (organism), present a remarkable coincidence with the multiplication and reproduction of the ferment in the fermenting substance. Now, since Pasteur's researches have established the fact for a great number of the fermenting processes that they are dependent on the presence and activity of certain organisms, and that the distinct fermenting processes are caused and maintained by specific, distinct organisms, but cease immediately after their death, a similar living cause would naturally be accepted, likewise for the zymotic diseases. Thus the theory of zymosis gave rise to the theory of contagion and miasma. But, although this theory rests, at present, also on entirely unproved suppositions, still, on the other side, it cannot be doubted, that the origin and the course of the epidemics often present circumstances which remind of the coming, the distribution, and the disappearance of certain low organisms. But the epidemic diseases of plants and insects yield much more definite proof, in which, through the application of exact methods of investigation, such a contagion vivum has really been found.

Thus the grape disease, which caused so much destruction in the vineyards, is caused by a fungus, (Oidium Tuckeri), which lives in the grapes and de-

stroys them (1). It has likewise been shown, that the fungus, (Peronospora infestans), which lives on the vines and fructifies there, is the cause of the Potato disease; its spores reach the bulbs through the ground, drive their utricles (Keimschlauch) into them, and grow in them into a mycelium, which pervades and destroys the bulbs, (2). Many epidemic diseases of the insects present similar circumstances.

The Muscardine, the well known epidemic disease of the silkworm, is caused by the vegetation of a parasitic fungus, (Botrytis Bassiana,) in the living animal, (3). Whilst the parasite lives on the blood and the soft part of the caterpillar, it becomes sick, and generally dies without being able to attain the normal full development into the butterfly. But the same disease not unfrequently appears epidemically also in other caterpillars living in freedom, as has been shown, a few years ago, by an epidemic amongst the Pinespinners, (Bombyx Pini,) (4), in the pine forests of North Germany. The epidemic disease of the fly, which frequently appears late in the fall of the year, already observed by Goethe, is likewise caused by the development of a fungus (Empusa Muscae) in the living insect, (5). But, besides those mentioned, other

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(1.) V. Mohl, on the Grape Disease. Botan. Zeit., 1852, p. 9; 1853, p. 585; 1854, p. 137.

(2.) A. de Bary. The present potato disease. Leipzig, 1861, and Recherches sur lè dèveloppement de quelques champignons parasites. Annales des sciences naturelles, iv. ser., tom xx., No. 1, p. 28.

(3.) A. de Bary. To the knowledge of the insect-killing fungi. Botan. Zeit., 1867, p. 1.

(4.) A. de Bary. Our knowledge of insect-killing fungi. Botan. Zeit., 1869, p. 585.

(5.) Brefeld. Investigations of the development of Empusa Muscæ and Empusa radicans. Abhandl. der naturf. Gasellsch. Halle, XII.

distinct insect-killing fungi are known, which at times also cause epidemic diseases amongst the caterpillars, beetles, etc. Probably the disease of the silkworm, called Gattine, is caused by the development of very minute vegetable organisms in the interior of the living animal, (6). In the named diseases of plants and animals, the art of infection, the propagation of the contagion, the relation between the progress of the disease and the progressing development of the fungi have been accurately observed, and corroborated by exact experiments. It is always the case that spores

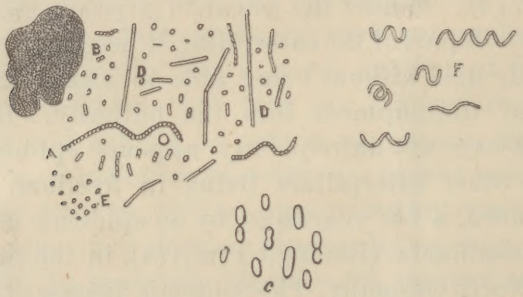

FIGURE 1.—Forms of schizomycites. Mag. 600, B, Bacterium termo in its distinct forms. A, Zoogloea. O, Leptothrix. D, Bacterium. F, Spirillum volutans from the same source. C, Nosema Boombycis, in the blood of the silkworm. Monos crepusculum. (Nach Lebert Virch. Arch. XII., tab VI., fig. 16.)

come on a plant or animal, germinate there, drive their utricles into the interior, and live and grow at the expense of the attacked individual until the entire supply of nourishment is used up. If, after the death of the animal, or the decay of the plant, favorable circumstances for the further growth of the parasite present themselves, it leaves the body of the animal for the development of the reproductive organs, the product of which then effects the further spreading

(6.) Frey and Lebert. Observations on the disease of the silkworm, raging at present in Venice. Virch. Arch. XII, 144.

of the disease. Diligent search has been made for a similar living organism in the infectious diseases of man and beast, but the results thus obtained have often been used in a manner unworthy of criticism, because the fungi thus found were at once identified with the contagion, and it was not at all considered necessary to furnish further proof. The literature on this subject, which has been considerably increased during the last years, furnishes the most wonderful examples of inaccuracy, for the greater part of these investigations were made by investigators who were not master of their subject, either in Path-

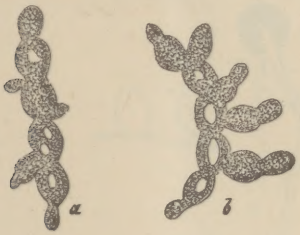

FIG. 2.—a, Saccharomyces cerevisiæ, mag. 400, from ale-yeast. b. Saccharomyces ellipsoides. mag. 400. from Lossnitzer's wine-yeast. (according to Ree's alcoholic fermenting fungi.)

FIG. 3.—Saccharomyces cerevisiæ. Spore development in Ascus, from culture in carrots. The letters a, d. e, f, distinct forms of the ripe Asci, mag. 750; (according to Rees, alcoholic fermenting fungi.)

ology or Botany, and hence it is no wonder that their results are unreliable. (7). But of late, a few exact observations and investigations have been produced, which are worthy of a critical consideration ; but it is necessary for a better comprehension of the subject, to precede them by a few preliminary remarks concerning the nature and mode of living of the organisms in question.

The vegetable organisms which can be regarded

(7.) Comp. the observations of H. E. Rechter, in Schmidt's Jahrbücher, CXXXV. 81, CXL. 101, CLI. 313.

as the causes of diseases in general, and of the infectious diseases in particular, belong exclusively to the lowest forms of vegetable life, where they moreover rank entirely by themselves. As regards vegetation, they are dependent on organic substances, because they lack the capability of producing from water, air, and inorganic mineral substances the organizable combinations of carbonic acid with hydrogen, oxygen, and nitrogen. This is a property of chlorophyll, and hence belongs exclusively to green-

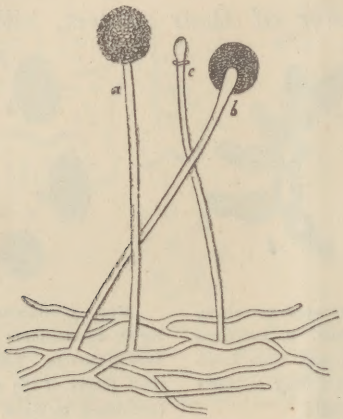

FIG. 4.—Mucor-Mucedo, mag. 250, from a vegetation on horse-dung. a, Ripe sporangium. b, Sporangium, before the spore formation. c, Cotyledons, after emptying the sporangium.

colored vegetation. The vegetable lacking chlorophyll is therefore dependent on organized substance, whether coming from animal or plant, and it either attacks living organisms, as a parasite, or dead, decaying organisms, as saprophytes, (inhabitants of putrefaction). The majority of these vegetable organisms belong, with the exception of a few forms belonging to higher organized plants, to the class of the fungi. Botany has separated the smaller part of them

as a group morphologically distinct from the fungi, and collected them under the name schizomycites.

The organisms belonging to the schizomycites (8), distinguished by their smallness, consist of cells of round, oval, or cylindrical form, which are either single or united into rows, and in the latter case can form also long, yet always unbranching strings. (Fig. 1.) They multiply by continuous cell division, so that the strings grow at all points through cell division. The cells, when greatly magnified, present contents of protoplasm, which holds in suspen-

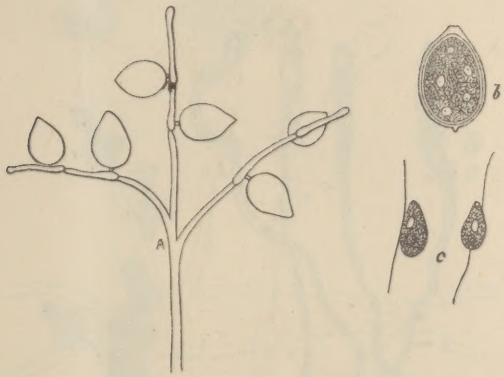

FIG. 5.—Peronospora infestans, on potato vines. a, Ramified carrier of sporangium, mag. 200. b, Sporangium with 5 spores. c, Zoospores, mag. 400, (according to de Bary.)

sion little granules, which have a high reflecting power, and a single well defined outline, not a double outlined cell membrane. The cells are generally colorless, but, under certain conditions, they produce from

(8.) The description of the schizomycites is given according to the older and later works by Cohn. Nova acta acad. caes. Leop. Carol. XXIV., 1, and Botanische Zeit, 1871, p. 861; further by Naegeli, on Schizomycites; Verh. der Naturforscher. Vers. zú Bonn, 1857. Botan. Zeit., 1857, p. 760, and de Bary, on mould and yeast; Samml. gemein. Vortraege von Virchow and Holzendorf, IV. Ser. Heft, 87 and 88.

the nourishing substratum also red, violet, green, blue, and yellow coloring substances, which they then hold imbibed. They are either immovable, or show more or less active signs of motion. A few forms move actively in the liquid, but the kind of motion cannot be recognized. Swinging cilia have not yet been definitely recognized on them. Other rod-shaped cells show an oscillatory, others a winding motion. The moveable cells can become stationary whilst they grow, by continuous cell division into long threads, or when they collect in groups, and exude between

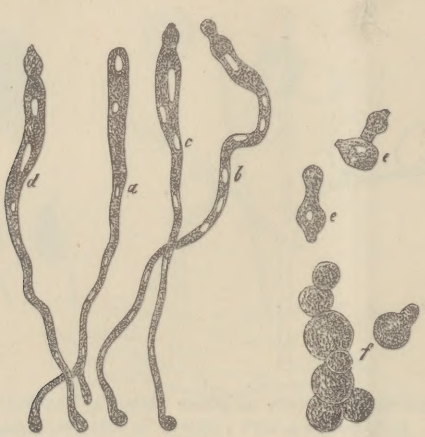

FIG. 6.—Empusa Muscae. a, d, Mycelium tubes, with simultaneous ligation of spores, according to the letters. Mag. 150. e, Germinated spores, ligating secondary spores, (sporidies, mag. 150.) f, Yeast-like proliferations of the sporidies in the blood the fly, mag. 400, (according to Brefeld.)

each other a transparent gelatinous intercellular substance, (Fig. 1, *a*.) Then they form irregular gelatinous masses, or gelatinous membranes, in which the cells are imbedded either single, or as thready interwoven cell-rows. In this state of rest the cells still continue to multiply by continued cell division. The threads formed by cell-rows are always single; ramifications are never observed on them. Especial or-

gans of reproduction have not yet been observed on these organisms. The maintenance of the species seems to be effected only in this way, as has been shown by experiments, that on evaporation of the liquid in which they are contained, great numbers are carried off with the vapor, and float in the atmosphere. If these schizomycites, floating in the air, come again into an adapted liquid, they again multiply by continued divisions.

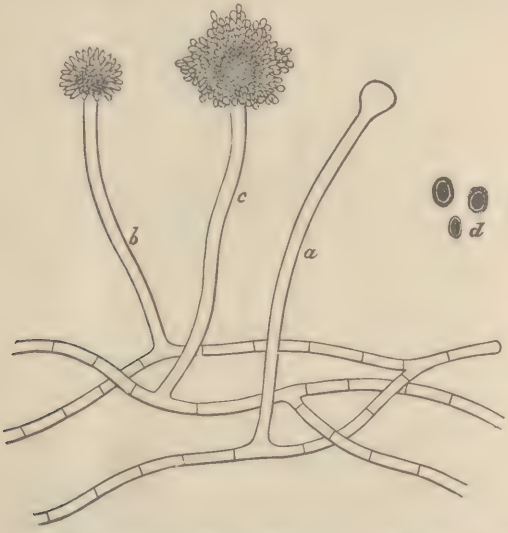

FIG. 7.—Eurotium aspergillus glaucus, mag. 400. a, Seed hyphe (Basidic) with bat-like, swollen end, showing, at b, the sterygmen which have sprung from it, which have ligated; at c, successive spore-chains; d, spores in different development, growing on preserved fruits.

A great many of the organisms belonging to the schizomycites are carriers of certain ferments, by which they produce in the liquids in which they vegetate, peculiar changes analogous to alcoholic fermentation. By such organisms alcohol is converted into acetic acid, milk sugar into lactic acid, and the complicated decompositions of albuminous substances,

which are known as putrefaction, are caused and maintained by them. On account of these distinct transposing processes, the active organisms have, in reference to a system, been separated into distinct genera and species, and the probability of a specific distinction cannot well be denied. But the morphological distinction can in many cases not be made, on account of their extreme smallness and similarity.

Bacterium termo, the cause of decomposition in albuminous substances, has by the latest investigations

FIG. 8.—Trichothecium roseum, mag. 400. Successive ligation of separated spores beside each other, according to the letters, a, c, on decayed wood in forests.

become the most prominently known (Fig. 1, *a*.) It appears in form of very small, sharp-bordered, round cells, which move actively in the liquid, and are described as Monas crepusculum. Besides these, we find rod-like cells (Bacterium), of very different lengths, with oscillatory motion; sometimes two or four are united to form a chain, (Fig. 1, A. D.) They arise from the round cells, growing longitudinally, and multiply likewise by cell division. Longer threads, consisting of short cells placed side by side, are further recognized,

and have been described by older observers as Leptothrix. (Fig. 1, *a*, *O*.) They arise by continued cell-division of the round or oval-shaped cells, whose products of division remain in connection. Finally the round or short rod-shaped cells are found united in masses and surrounded by a transparent, gelatinous mass (Fig. 1, A B,) like the Palmellen, and de-

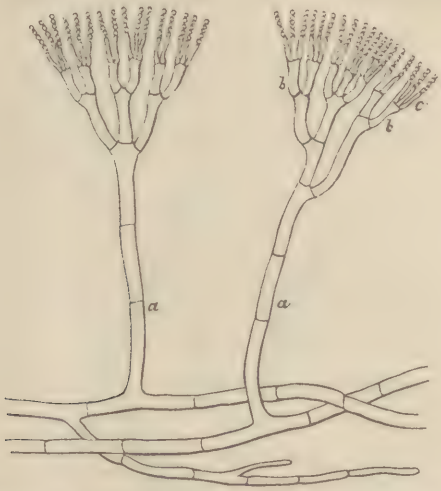

FIG. 9.—Penicillium glaucum, mag. 400. a, Ramified seed-hyphe. b, Basidics c, Sterygmen, with successive ligation of spores, on bread.

scribed by older observers as Zoogloœa. These different forms belong, therefore, entirely to one species, and present only distinct forms of development. They are those which cause and maintain the processes of putrefaction in organic substances, because they assimilate the soluble albuminous substances, partly as food, and decomposing them partly, and render the insoluble soluble for the same purposes.

Little is known of the schizomycites named Spirillum volutans, (Fig. 1, *F*); thin, spiral-shaped, cylindrical bodies; Nosema Bombycis, (Fig. 1, *c*,) oval bodies, with oscillatory motion.

The fungi are essentially distinct from the schizomycites (9). Their vegetative body, thallus, consists, with few exceptions, of more or less richly ramified, thread-like elements, the fungi threads or hyphe being either formed by a single ramified tube-shaped cell, or consisting of cell-rows, because the hyphe is divided by partitions into more or less long cylindrical cells. In both cases the enlargement of the hyphe takes place only by the growth of the joints, so that in a hyphe consisting of a cell-row, the end cell only divides. The ramification of the hyphe is either dichotomous, or arises from development of

FIG. 10.—Mucor Mucedo, mag. 400. Gemmen, or incubating cell formation, from an old culture on horse-dung.

the member cells. A few forms differ from this description in regard to the construction of the thallus. The yeast fungi (Saccharomyces) consist of ramified cell-rows, arranged like the rosary, whose single elements, round or oval, are only loosely connected with each other (Fig. 2). Their growth consists in the formation of peculiar sprouts (Fig. 2, a.), which can

(9.) The description of the fungi is given according to de Bary: Morphology and Physiology of the fungi, in Hofmeister's Handbook of Physiology. Botanik, II., 1.

arise at any desirable point of a cell, and by gradual enlargement, organize into a new cell only loosely connected with the first one.

The single tube-shaped hyphe, as well as those consisting of cell-rows, present a distinct double-outlined, at times, very tender cell membrane. It contains contents of nearly homogenous protoplasm, which frequently contains vacuoli and fine drops of fat. A nucleus has not yet been observed in the cells of the hyphe.

The fungi thallus is divided into two parts of distinct formations, mycelium and cotyledons. The mycelium is formed from hyphe, which ramify in the nourishing ground of the fungi and entwine loosely, or unite into a membranous expansion, or form finally, by an intimate entwining, firm tuberculous bodies (Sclerotie). The cotyledons arise from the mycelium, which produce and carry the reproductive organs, either as a single seed hyphe, or as compound seed-bodies of hat, cup, or knob form.

The seed hyphes arise from the mycelium as upright threads, and are either single (Fig. 4 & 7), or ramified in a characteristic way (Fig 5, 8, 9). The propagation of the fungi is performed in a sexual and also an unsexual way.

First, in regard to the unsexual propagation, the cells destined for reproduction, spores, can be formed in three different ways; by free sporetube cellformation within an enlarged cell (Ascus), by free cell division within an enlarged cell, (Sporangium), by ligation of a cell, (Basidium.)

The Ascus fructification generally takes place in compound, at times, very complicately built seed-bodies, in which the sporetubes arise as tender cells,which grow rapidly into their destined size, and generally

present a bat-like, oval, or globular form. In the yeast fungi the cells of the thallus, in case that they come under adapted circumstances, increasing considerably, change into spores, (Fig. 3). The formation of the spores takes place thus: a part of the protoplasm of the Ascus adheres, by a kind of furrowing, into a number of round bodies, which then surround themselves with a tender membrane. (Fig. 3, b.c.d.). Each body then forms a distinct spore.

In many fungi the process of furrowing is preceeded by the appearance of a nucleus in the Ascus, which, by continued division, multiplies into the number of spores to be built. Around each nucleus the protoplasm then groups for the formation of a spore. The number of spores formed in an Ascus is definite for the individual species of fungi, generally 8, for a few species it is indefinite. (Saccharomyces, 2–4; Fig. d.e.f.g.).

The second form of spore building in the sporangium, thus takes place: the end-cell of the seed-hyphe (Mucorinen) (Fig. 4), or its ramifications (Peronospores, Fig. 5), changes into maternal spore-cells filled with granular protoplasm, the entire contents of which are divided into a number of equal portions. Of these, each one then partakes of the character of a spore. In most cases each of the spores thus formed surrounds itself while still within the sporangium with a tender cell-membrane.

The third form of spore formation by ligation, takes place either in single or ramified seed-hyphe, or in compound seed-bodies, and the cells begetting the spores are designated Basidies. They ligate them either directly (Fig. 6–a.d.), whilst the point swells somewhat, drives a button-like prominence, which then separates itself from the Basedie, and by a parti-

tion; or especial prolongations sterygme are driven from the Basedie, at which point the spores are then ligated in the manner just described (Fig. 7 b). The spore-ligation is either spontaneous, *i. e.* at the point of a Basedie or Sterygme only a single spore is ligated, (Fig. 6, d.), or it is successive, several spores are ligated after each other from the Basidie or Sterygme. In this way the second spore in many species arises close beside the point of insertion of the first, which is then pushed to the side, the third arises beside the second, etc. (Fig. 8. a.c.). Thus the development of spore-heads takes place. In other cases the second spore is ligated close under the first one with which it yet remains in connection—if this is often repeated then the formation of spore chains ensues (F. 9, c.).

Besides these three forms of spore formation, many species of fungi can produce propagating organs at any desirable point of their mycelium, which are then designated incubating cells, and which by means of their germinating property attach themselves to the spores. The development of such incubating cells takes place in this manner: the hyphen are divided by diagonal walls into short member cells, which surround themselves with a coarser membrane, and contain a great amount of granular protoplasm (Fig. 10). They arise chiefly when the species of fungi in question does not find the proper conditions of regulation for the development of the typical organs of propagation.

In regard to the construction of the spores, we have to distinguish between moveable spores (Zoospores) and the immovable ones. The first belong only to a few species, (the Saprolignies and a few forms of the Peronospores). They are round or oval

bodies, devoid of a cellular membrane, endowed with one or two cilia, by means of which they move actively in water. (Fig. 5, c.).

The immoveable cells have at the time of maturity a coarse cell-membrane, which frequently presents a separation into two layers, an inner Endosporium, and an outer one, Episporium. In many cases the latter presents a swarthy or thorny roughness. (Fig. 7, d). The spores are generally devoid of a nucleus, and present homogeneous contents, sometimes rendered opaque by granules and fat-drops. In many species the spores originally formed are divided by the secondary formation of partition cells, into two, or more parts, each one of which partakes of the character of a spore. They are designated, separated or compound spores (Fig. 8, c.).

The form of the spores in the different species of fungi changes in various ways. They are globular, oval, cylindrical, lenticuler, and pear-shaped. When germinating the spore swells, and drives then in one or two directions a tubular nucleus, Promycelium, enveloped by a prolongation of the endosporium, which ramifies according to the nature of the spores, forms partition walls and grows, thus, into a new mycelium, which then again produces the typical reproductive organs. In other cases the Promycelium has a certain limit of growth, because it ligates immediately spores of second order, sporules, (Fig. 6, e.) after which the Promycelium perishes. The real mycelium with the typical reproductive organs arises by germination, from the sporules. But, in many species further species of sporules are produced, even from the spores and sporules (Fig. 6, f.), out of which, then, under favorable circumstance, the mycelium shoots forth.

A similar process takes place in the spores and germinating cells of Mucor Mucedo, when they are cultivated, immersed in solutions capable of fermentation. Under considerable swelling of the spores with the formation of vacuoles in the protoplasm, otherwise quite homogeneous, they project blister-like prominences as the yeast fungi, which then separate themselves by diagonal partition walls, in order to develop further buds(prominences). Thus,countless generations of globular cells arise, which have been called ballyeast, also from the mycelium strings, which are cultivated, immersed in a liquid capable of fermenting, globular yeast arises from the cells formed by the formation of numerous partition walls and yeast-like proliferations.

In a number of fungi a sexual propagation is also known, whose product is called Oospore; it has become better known in the Saprolignies and Peronospores. To this class belong also the formation of the Zygospores in the Mucorines, caused by copulation and, the origin of the Perithecien in the Erysiphe, Eurotium and Penicillium, forming the Tube-spores.

Several of the above described forms of fructification belong to a great number of the fungi, which develop, one after another, partly in a definite order, and partly arising only under conditions of vegetation as yet unknown.

This phenomenon, discovered 20 years ago by Tulasne, which has since received numerous ratifications, has been designated pleomorphism. Thus the mycelium of the widely distributed mould fungus, Eurotium aspergillus glaucus,first produces cotyledons, which ligate sporechains on numerous sterygmes,(Fig. 7), later perithecies develop on the same mycelium, which produce spore-forming Asci in the interior. Before this

connection was known, the two distinct forms of fructification had been described as two distinct fungi, growing sociably beside each other, the first Aspergillus glaucus, the latter as Eurotium herbariorum.

During the last years, Hallier, relying on pretended clean culture apparatuses, has given a development to the pleomorphism of the fungi, which, if it were correct, would simplify extraordinarily the so exceedingly difficult systemification of the fungi. After he had obtained very distinct species of fungi from the schizomycites, which are morphologically distinct from the fungi, by pretended cleanculture, according to the employed substrata, he drew the conclusion from this fact, that the most of these forms of fungi, described as distinct genera and species, represent only distinct stages of development of one individual, depending on conditions of vegetation. He maintains, therefore, to be able to breed by cultivation forwards and backwards, by changes in the conditions of vegetation, starting from the schizomycite forms, (Micrococcus, Hallier,) yeast, mould-forms, and mycelium-forms of various structure, even to the transition of the larger hat-fungi into ramifications, (10).

Hallier's doctrine of the Pleomorphism of the fungi has unfortunately received nearly an unscrupulous reception amongst physicians, whilst nearly all botanists have rejected his assertions as false, and his methods of investigation as unscientific. It cannot be the object of this paper to give a detailed contradiction to Hallier's assertions, the less so since it has already proceeded from a more weighty source, in a manner more than sufficient, (11).

(10.) Uebersichten von H. E. Rechter.

(11.) A de Bary. Report of the fungi found in the cholera de-

I have already remarked that the fungi are dependent, in regard to their nourishment, on organic substance. They are therefore only found on organic bodies, living or dead. According to their mode of life, they can be divided into two great groups: in parasites, which settle themselves on or in living animals, and take their nourishment out of them; and in saprophytes, which inhabit only dead, decomposing, organic substances. However, of the first a few seem to begin their development as real parasites, and to terminate as saprophytes, because they first develop their typical reproductive organs after the death of the host, (12).

The saprophytes cause, by their vegetation, changes in the substrata which they inhabit, which can be ranked beside the symptoms of putrefaction caused by the schizomycites in general, but of which, as yet, little is known. The effects of a few species on the substrata and their products, have been studied more accurately, and so also the forms of the Saccharomyces, which, in liquids capable of fermentation, change grape sugar into alcohol and carbonic acid. However, the spores and mycelia of Mucor Mucedo and racemosus show the same effects of fermentation, although not so energetically, when they are immersed in liquids capable of fermentation. They develop thereby the globe-yeast already men-

jections. Virchow and Hirsch. Report of the work of medical investigations in the year 1867, II., 240.

(12.) Botrytis Bassiana, Empusa muscæ, Cordiceps militaris, develop their reproductive organs first after the death of the attacked insect. But during this time the interior of the insect is so completely filled up with the products of vegetation of the fungi in question, that it is also possible that the organs of reproduction, which now appear, take their nourishment from the fungous elements previously formed.

tioned. Of other mould forms similar changes are known, (13).

The parasitic fungi call forth numerous disturbances of development and growth in the organs of their host, which can finally cause either his death, or the death of single parts.

If now, after these necessary botanical preliminary remarks, I turn to the real subject of discussion, to the vegetable organisms as far as they are known as causes of disease in man, I must, at first, remark that our knowledge of them, in a botanical point of view, is yet, at present, very imperfect.

From the great number of observations on the appearance of fungi in morbid processes, laid down in the literature of the subject, many, whose parasitic nature is questionable, are first to be discarded. They pertain to the vegetations of fungi which had infected external and internal cavities of the body, especially the outer auditory meatus, bronchial dilatations and cavities of the lungs, and belong to the universally distributed mould-forms, Aspergillus, Penicillium, Trichothecium, Mucor, etc. They stand in no causal relation to the disease which may be present, but develop only on tissues already dead or stagnant secretions, whose decomposition they promote, by which, at all events in certain cases, symptoms of irritation are called forth ; as, for example, in the tympanum. They are, therefore, by no means to be considered as specific causes of disease. (14)

(13.) Thus Penicillium glaucum and Eurotium aspergillus niger according to Van Tieghem, by luxuriant vegetation on Tannin-solutions, their decomposition into Gallic acid and sugar, a process analogous to alcoholic fermentation.

(14.) The growth of fungi in the outer meatus has been frequently observed. Thus by Cramer: Zeitschrift der Schweitzer naturforschenden Gesellschaft.

Independent of these saprophytic fungi, we have become acquainted, since Schœnlein's discovery of the parasitic nature of the favus, with a number of genuine parasitic fungi which inhabit the integument and mucous membrane, and cause specific, distinct conditions of disease. They are the Achorion Schœnleinii, the favus fungus, Trichophyton tonsurans, the fungus of herpes tonsorans and of the sycosis, Microsporon furfur, the fungus of pityriasis versicolor and Oidium albicans, the soor fungus. The diseases of the skin and mucous membrane caused by them are indeed only local, but distinctly contagious ; the distribution, and the conveyance of the diseases to other individuals can only be accomplished by means of the propagating cells of the fungi. The named species of fungi have as yet been imperfectly studied in a botanical point of view. In these fungi we know nothing but the mycelium strings, which divide at single points, by the formation of numerous partition walls, into short cylindrical cells, which detach themselves from each other and assume a globular form, and are then lying single, or in groups between the ramified and intertwined mycelium strings. There are, in general, falsely designated spores, for they are only propagating cells, destined for the maintainance of the spe-

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Mayer: Mueller's Archiv für Anatomie und Physiologie, 1844, p. 404. Pacini Gaz. Med. Ital., 1851, I., Ser. II.

Schwartze: Archiv für Ohrenheilkunde II., 5.

Wreden: Archiv für Ohrenheilkunde, III.

Wreden: Myringomycosis aspergillina, Petersburg, 1868.

Steudener: Archiv für Ohrenheilkunde, V., 163.

Comp: On formation of fungi in the lungs.

Virchow: in Virch. Archiv, IX., 558.

Friedreich: Virch. Archiv, X., 510.

v. Dusch u. Pagenstecher: Virchow Arch. XI., 561.

Cohnheim : Virch. Arch. XXXIII, 159.

cies, just as the germinating cells or gemmen of mucor mucedo, fig. 10.

Typical organs of reproduction are not known of them ; but they may develop themselves on other substrata, or under other conditions of vegetation. Lately, the view obtained of them by unclean culture-experiments has been much discussed and promulgated, viz : that they are in relation with other known species of fungi, especially the extensively distributed mould fungi, Aspergillus, Penicillium and Mucor, and represent their mycelium which produces the germinating cells. (15.)

But heretofore the experiment never succeeded in producing the skin diseases in question by inoculating with the spores of fungi, whilst they are easily transported by the germinating cells of these parasities. (16.)

The fungi, infecting the integument, restrict their vegetation to the middle and deeper layers of the tissue and their continuation into the cutis, but the latter is almost never infected by them. They cause, there, at times only slight irritations, but at times also symptoms of inflammation of different forms, (exudation, ulceration.) Oidium albicans vegetates, in deed, also generally in the middle and deeper layers of the mucuous membranes of the mouth, pharynx œsophagus, and vagina, but it happens, sometimes, that the parasite drives its mycelium-strings

(15.) This view was first advanced by Tilbury Fox, and believed greatly in England. In regard to its contradiction comp. A. de Bary Morphologieder Pilze, etc., 224.

(16.) In regard to these experiments comp. Köbner : Klinische and experimentelle Mittheilungen aus der Dermatologie und Syphilidologie. Erlangen 1864.

even into the mucous membrane. Indeed, it has even been found within the blood-vessels. (17.)

This can finally lead to fungi-emboli, as is demonstrated by a case observed by Zenker, in which simultaneously with the soor of the pharynx and œsophagus, numerous small abscesses were found in the brain, the centres of which were formed by mycelium strings of the construction of Oidium albicans. (18.)

The vegetation of this fungus in the epithelium of the mucous membrane causes generally more important symptoms of inflammation than the species of fungi are apt to produce which inhabit the integument, and in many cases symptoms of fever have been observed in connection with it.

But, in general, the symptoms of disease, caused by the four named species of fungi, are local and unimportant, and are generally easily removed. In opposition to these, we have lately become acquainted with a parasitic fungus, which causes so important destructions, that its removal finally requires important surgical operations. It is the Chionyphe Carteri, which causes, in certain districts of India, the endemic disease mycetoma, better known as madura-foot (19.)

As already indicated by the latter name, the disease appears most frequently on the lower extremities. The fungus infects here at first the subcutaneous cellular tissue, which is greatly thickened by inflammatory infiltration. Gradually, it attacks also the deeper structures, which likewise become greatly indurated, so that the foot is finally converted into a

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(17.) Wagner: Jahrbuch für Kinderheilkunde, 1868. I., 58.

(18.) Zenker: Jahresbericht der Gesellschaft für Natur und Heilkunde in Dresden 1861–62.

formless mass. Later, suppuration and perforation take place at one or more points of the swelling. The openings, thus produced, lead into fistulous sinuses, which traverse greatly the swollen soft parts, and separate a thin pus-like liquid, which holds in suspension more or less numerous circular black bodies. Similar blackish masses, from the size of a millet seed to that of a bullet, are found imbedded in great numbers in the inflammatory infiltrated soft parts, they have even been found in the marrow of bones. The blackish bodies consist of mycelium strings, which are formed greatly ramified from cell rows, the individual members of which appear greatly lengthened. They present a coarse cell membrane and contain homogeneous protoplasm, which often presents vacuoles and droplets of fat. Short branches arise from the mycelium strings, which carry the blackish sporangies. (Fig. 11, b and c.) They present a globular form with an undulating surface, and are frequently surrounded by a net-work of fine hyphes, which seem to arise from the supporter of the sporangium. The spores present a lengthy oval form, and on each end a fat droplet. The development of the sporangies seems to depend on the more rapid growth of the end cell of the supporter of the sporangium, (sporangiumträger), (fig. 11, a.) but the finer processes in connection with it are not yet known, (20.)

The disease is found almost exclusively on the feet, very seldom on the hands, and nearly without exception the people wearing no shoes are affected with it. Little is known of the manner of the infec-

(19.) Hirsch: Ueber den Madurafuss. Virchow's Archiv. XX VII. 98.

(20.) Berkley has given a description of the parasites with plates,

tion, according to the opinion of the Indian physicians, an injury of the skin is necessary, through which the parasite gets into the cutis and the subcutaneous cellular tissue.

But not alone in outer parts, also in inner organs, a participation of vegetable organisms in certain morbid processes has lately been observed. Leyden and Jaffe (21) have demonstrated the presence of schizomycites, (Bacterium termo) in its distinct forms, and Spirillum volutans,) both in the sputa and the diseased structures of putrid bronchitis and gangrene of the lungs. But here they are not to be regarded as the causes of the *processes of disease*, but only as the causes of *putrefaction* in the dead lung tissues, and the stagnant bronchial secretions, for their germs can easily get to these parts by respiration.

It is different, however, in the case of pyelonephritis, which is frequently developed in consequence of chronic catarrh of the bladder. Traube (22) has first shown that germs of schizomycites are frequently conveyed into the bladder by the introduction of the catheter, and on account of their further development and multiplication convert the simple catarrh into putrid suppuration. The moveable bacteries wander through the ureters into the pelvis of the kidney, the sinuses of which favor their undis turbed multiplication. There they cause a suppurative pyelitis, and finally enter the tubuli uriniferi, the epithelium of which they destroy. Then they wander into the interstitial tissue of the kidney, and cause in-

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partly after the drawing of Carter in the Proceedings of the Linnean Soc. 1865. VIII., 139.

(21.) Leyden und Jaffe: On putrid bronchitis.

(22.) Traube: Berliner Klinische Wochenschrift 1864. No. 2.

flammatory irritation in a high degree, because interstitial suppuration ensues now with its further heavy consequences for the organism. The kidney is found traversed with large and small abscesses, partly confluent,in which the bacteries are always present. This affection of the kidney could rightly be designated parasitic nephritis. (23.)

In the diseases hitherto discussed, vegetable organisms have thus been certainly demonstrated as the specific causes of disease, and the conveyance of the diseases in question, by means of the propagating cells of the parasites, has also been partly corroborated by experiments. But, in regard to the real infectious diseases, we still find many chasms in our knowledge of the causes of those diseases, which must be bridged by further investigation in this field. The cause of this lies in the difficulty of the investigation and the experiment. If here, as the zymotic theory demands, vegetable organisms are the causes and distributors of the diseases, they certainly belong to the smallest forms, probably schizomycites, the smallness and similarity of which render exact investigations and experiments really so exceedingly difficult. Nevertheless, numerous investigations have lately been made in reference to the causes of the infectious diseases, but, with few exceptions, in such a worthless way that the question pertaining to the nature of the infectious substances has not been advanced at all; on the contrary, they have called forth among physicians and botanists a just suspicion of these parisitological investigations, and the parasitic theory of the infectious diseases in general.

Most of these works are based, in a botanical

(23.) Klebs: Handbuch der pathologischen Anatomie. 654.

point of view, on Hallier's views, who, without being a physician, has been very productive in this field. In these investigations the spores of fungi, or forms of schizomycites (micrococcus), which were found especially in the contents of the alimentary canal or in the blood, and had come there accidentally, were, without any further consideration, identified with the cause of the disease. And whilst the liquids in question were cultivated in so-called clean culture apparatusses, the botanical species of the cause of disease was then determined, according to the forms of fungi washed out, which often differed greatly. To furnish proof for the promulgated views by clean experiments was never considered necessary. (24.)

These investigations were also extented to the field of physiology, and all changes in the body, depending on the effects of fermentation, were traced back to the influence of vegetable organisms. Thus, a micrococcus was discovered in the fine albuminous and fat granules of the salivary and hepatic cells, just as many a fine-granuled detritis, of most distinct nature and origin, has been described as micrococcus. (25.)

Amongst the few infectious diseases in which a vegetable organism, a living virus, has been demonstrated as the cause of disease, and investigated by scientific methods, pyæmia and septicæmia take the first rank. Klebs has the merit of being the discoverer, of having pursued most accurately its mode of distribution and its influence on the organism, and of having proved the correctness of his view by ex-

(24.) Most of these works have been published in Hallier's Zeitschrift für Parasitenkunde.

(25.) Bechamp, Estor, et St. Pierre : Du role des organismes mi-

periments. (26.) According to his investigations both diseases are caused by the same parasite.

Klebs found in the investigation of the wound secretions, in the thin ichorous as well as in the thick creamy pus, almost always vegetable organisms in varying numbers. Unusually numerous in thin ichor, less numerous in good pus, but never wanting entirely in the latter. They presented themselves as very small round cells of $0._5$ mikrmm. diameter, partly in active motion, partly immovable in masses lying close together. Beside them were found rod-shaped bodies with oscillatory motion, or immovable, arrayed side by side as long membered threads: finally the round cells above described united into longer rosary-like threads. Klebs regards these different forms, as belonging together, under the name Microsporon septicum. (27.)

According to their morphological condition they belong, at all events, to the schizomycites, Bacterium termo and its distinct stages of development, as Zoogloœa, forms similar to Leptothrix. On further investigation, Klebs found these organisms in zoogloœa forms settled on granulation tissue and ulcerating cartilage. He pursued their entrance into the secretion cavities of the cellular connective tissue, where they cause inflammation and ulceration, and their entrance into the medulla causes also the traumatic osteomyelitis. Here he also observed their destructive influence on the vessels which they enter by de-

croscopiques de la bouche dans la digestion Montpellier 1869. Schmiedt's Jahrbücher. CLI., 326.

(26.) Klebs, Beitræge zur pathologischen Anatomie der Schusswounden. Leipzig 1872.

(27.) The designation microsporon septicum is not well selected, since it might easily lead to regard it in relation with microsporon furfur.

stroying the walls, and produce either attached or obstructing thrombi, or they enter the circulating blood directly. Then they prefer to settle at such points in the vessels remote from the wound where the current of blood is both steadier and slower. They are, therefore, frequently found behind the valves of the veins, where they then cause inflammatory irritation of the inner coat (intima) and secondary *thrombi*, indeed, even ulceration. They are also present in large numbers in the thrombi, and they alone cause their destructive decomposition. If the thrombi, filled with parasites, come into the circulation, they will next produce an infarction, in case that they are carried into a terminating artery. The organisms contained in the embolus then, multiplying rapidly, enter the infarct and cause its suppurative liquefaction, the result of which is the well-known conical metastatic abscess. If the embolus remains in an artery which is not a terminating one, but forms anastamoses with neighboring arteries, then it does not produce an infarction, but the organisms contained in it enter the tissue and cause inflammation and suppuration. (28.)

But such metastatic abscesses arise also without the presence of emboli, by the settling and multiplication of the organisms, contained in a free state in the circulation, in the capillaries, from whence they invade the tissues and cause suppuration. This process is noticed, especially in pyæmic abscesses of the liver. The great distribution of these organisms in the bodies of pyæmic patients, and especially their relation to the secondary suppurations made it very probable that the cause of the entire morbid process

(28.) These observations of Klebs coincide with Cohnheim's experimental results : Untersuchungen über die embolischen Processe. Berlin 1872.

is to be looked for in them. The experiment corroborated the truth of this supposition completely. Wound secretions containing these organisms in great numbers, were filtered through clay cylinders, and the filtrate thus obtained, being entirely free from them, was injected subcutaneously into animals. The symptoms arising in the animals experimented on showed more or less violent fever, which passed off in a few days. None of the animals experimented on died, and even after repeated injections, local or

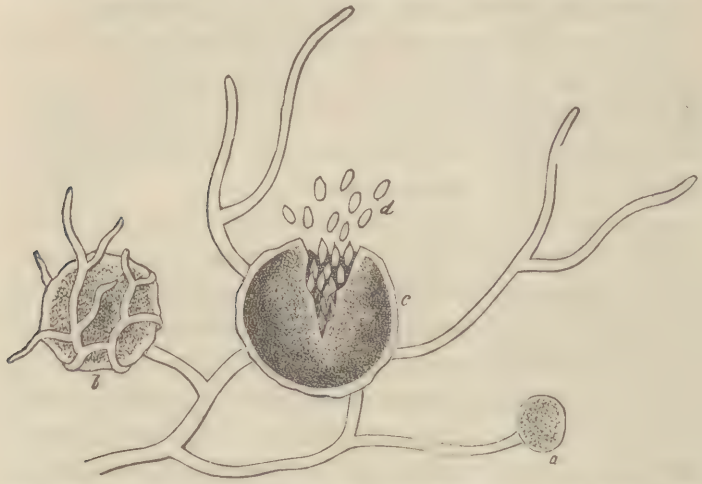

FIG. 11.—Chionyphe Carteri, mag. 450. Part of a mycelium, with 3 sporangies, according to an old drawing of Carter, (Proceed. of the Linu. Soc., ven. iii., tal. ii fig. 1.) a, First stage of a sporangeum. b, Sporangeum nearly fully developed, surrounded by five hype. c, Ripe sporangeum, opened and discharging its spores.

metastic suppuration never occurred. But if liquids containing the fungi, were injected, then the animal died in a few days, and extensive suppuration appeared always at the point of injection. (29.)

(29.) Neither would this experiment furnish an entirely unobjectionable proof, since, in filtering, other corporeal elements (pus cells) of the wound secretions remain behind, to which the infecting material might be attached. But if we consider how different pus, injected into

The results of these experiments give us also indications of the influence of these organisms on the origin of the fever. They cause by their vegetation, or by a ferment which they contain, chemical changes in the wound secretions or blood to whose products the pyrogenic effect is to be ascribed.

Since Klebs found these organisms in the pyæmic, as well as in the septicæmic process, and these two wound diseases, hitherto strictly separated, show besides this many transitions which do not admit of a separation of them, from an anatomical point of view, he regards them as one morbid process, the distinct course of which depends on the slower or more rapid and extensive invasion of these vegetable organisms, and on the pyrogenic material developed by them in the circulation.

In another morbid process, which belongs really to veterinary medicine, but on account of its frequent conveyance to man demands medical interest in a high degree, viz : gangrene of the spleen, Davaine, a few years ago, has likewise made the existence of a contagium vivum probable. Pollender (30) had already discovered, 17 years before, numerous immovable rod-like bodies in the blood of animals which died of gangrene of the spleen. Brauell (31) corroborated this observation a few years later and proved likewise their appearance in the blood of the diseased animal, a short time before death.

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a vessel, acts, how such an injection, at times, does not produce any disturbance, and again, in other cases, is followed by the gravest symptoms of disease, we must come to the conclusion that this action is not due to the pus, but to other substances, vegetable organisms, attached to it.

(30.) Pollender : Casper's Vierteljahrschrift für gerichtl. Med. 1855. VIII., 103.

(31.) Brauell : Virchow's Arch. XL. 137. XLV. 432. XXXVI. 292.

He regards them as infusoria (bacteries) belonging exclusively to gangrene of the spleen, out of which, after the death of the animal, movable vibriones are developed, partly immediately, partly after their destruction into little granules. In regard to their action in gangrene of the spleen, he defends firmly the view, that they are neither the cause of the disease nor the carriers of the contagium, but are only of consequence in regard to the prognosis.

Dalefond (32) confirmed Brauell's observations in regard to the appearance of these organisms in the blood before the death of the animal, but rejects his assertions, that they are later developed into vibriones. He regards them as vegetable organisms in close relation to the alges, and sees in them the contagium of gangrene of the spleen. After the death of the animal he still observed a growth of the rod-shaped bodies, but vibriones first appeared with the beginning of putrefaction of the blood of gangrene of the spleen. The rod-shaped bodies disappear more and more as the vibriones increase in number, because they perish by decomposition.

Davaine (33) had likewise already (1850) observed these organisms in the blood of animals that died of gangrene of the spleen, without, however, ascribing any significance to them. But under the influence of Pasteur's discoveries of the action of low organisms appearing in distinct processes of fermentation, he at once resumed his investigations of gangrene of the spleen on an extensive scale, and sustained his views

(32.) Delafond. Recuil de la Med. veterin. IV. Ser. vèú Int. Sept., 1860, referirt im Repert. der Thierheilkun le XXII. 31.

(33.) Davaine: Compt. rend LVII. 220, 351, 386. LIX. 393. Mém. de la Societé de Biologie 1865. III. Ser. V. 193. Vergl. Schmiedts Jahrbücher CXXXVIII. 37.

thus obtained by numerous experiments. Davaine found the rod-shaped bodies constantly in the blood of all animals that died of gangrene of the spleen, whether they had taken the disease spontaneously, or by inoculation, but missed them constantly in the blood of healthy animals, or that died of other diseases, and from this circumstance he already drew the conclusion, that they stand in a causal relation to the named morbid processes. Since he further found them already in the blood of the diseased animal before its death, he pursued their development by inoculation. This showed that for some time after the inoculation (until 48 hours) the rod-shaped bodies were not yet in the blood of the inoculated animal, but presented themselves on the appearance of the first constitutional symptoms of the disease, and then multiplied very rapidly until the death of the animal under experiment, so that their multiplication corresponds with the increase of the symptoms of the disease. He found them not only in the blood, but in all organs, never, however, in exudates and secretions, with which inoculation also never succeeded.

Davaine describes these organisms as cylindrical, unramified straight strings, of $0.^{004}$—$0.^{05}$ mm. in length, and of great fineness, of which the longer generally present one or two depressions, which last appearance may well be regarded as the beginning of a division. They show no independent motion, and are *not identical with Bacterium termo*, for when blood decomposes which contains these organisms, they disappear by decay and make room for bacteries and vibriones. Davaine, regards them, therefore, as a distinct species of vegetable organisms related with Bacterium termo, Mycoderma aceti and other organisms of fermentation, and designates them Bacteridies. He

mentions nothing regarding their first development and probable polymorphism similar to Bacterium.

Davaine now regards these organisms as the real cause of gangrene of the spleen, by the vegetation of which decompositions analogous to the fermenting processes are produced in the blood, and with this view relies especially on his attempts of inoculation. Only blood containing the bacteridies is capable of transporting gangrene of the spleen, for which a minimum number suffices. If an animal, inoculated with blood of gangrene of the spleen containing bacteridies is used, for further inoculation, before the bacteridies are developed in its blood, the inoculation remains entirely without success ; the same happens if the blood of gangrene of the spleen is used for inoculation which has been left decomposing until the bacteridies have disappeared in it. The loss of the power of infecting corresponds, therefore, with their disappearance. But dried blood retains its infecting power for months, but the bacteridies are then also found in it well preserved. (34.)

Unfortunately, Davaine neglected to make the one experiment which would have removed all objections against his view of the importance of bacteridies in gangrene of the spleen; the liberation of the blood from bacteridies by filtering it through a clay cylinder, and inoculating with the filtrate.

Davaine (35) has further, also, demonstrated the connection between the pustula maligna in man and

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(34.) The extraordinary power of infection, possessed by dried skins of animals which died of gangrene of the spleen, agrees exceedingly well with this. Vergl. Hasselbach. Mag. f. die gesammte Thierheilkunde XXVI. 201.

(35.) Davaine Compt. rend. LIX. 429. LX. 1293. Arch. general, October. 1864. pag. 498.

gangrene of the spleen, which seems still to have been doubted in France, once by demonstrating the presence of the bacteridies in the pustal itself, and in the blood of persons that died of the disease, and again by producing gangrene of the spleen in animals inoculated with an excised pustula. The conveyance of gangrene of the spleen to man takes place thus ; the bacteridies get into the rete malpighi, there they first multiply and then they enter the circulation by means of the lymphatic vessels, or directly by entering the blood vessels.

Davaine's discoveries found in his time, in general, little belief and many opponents. (36.) It would, however, lead too far to discuss all the objections raised against his views, and I shall limit myself to the remark; that Davaine's statements, according to which the bacteridies are developed in the living animal, and that the blood is capable of infecting when it contains them, but that the blood of inoculated animals, if does not yet contain any bacteridies, can not produce an infection, have not been disproved. Thus Münch (37) has observed in a great number of cases of gangrene of the spleen in man, the same affections of the alimentary canal partly with and partly without outer localization, as they have long ago been known in animals. They present themselves as larger and smaller hemorrhagic infiltrated masses, with flat incrustations in the centre, in the mucous membrane of the stomach and the entire alimentary canal.

(36.) Amongst the objections raised against Davaine's views of the nature of gangrene of the spleen is yet to be mentioned, that the bacteridies have been regarded as exudates of fibrine. But the microchemical investigations of Pollender, Brauell and others, show the fallacy of this objection.

(37.) Münch : Centralblatt der Med. Wissenschaften 1871. page 802.

Probably similar cases of such affections of the alimentary canal observed by Buhl (38.), Waldeyer (39.), Wahl (40) and von Recklinghausen (41) belong to this affection, in which strings, like the bacteridien strings, were found in great numbers in the infiltrated patches of the mucous membrane, which could be traced into the lymph and blood-vessels, whilst numerous shorter rod-like bodies were also found everywhere in the blood. (42.)

According to this, gangrene of the spleen seems really to depend, like pyæmia, on the entrance of vegetable organisms into the circulation, and the decomposition of the blood, analogous to the fermenting processes, thus produced. (43.)

Recent investigations have likewise proved the probability of the participation of vegetable organisms in diphtheria. Buhl (44) had first drawn attention to the constant appearance of forms of schizomycites in the diptheritic *plaques*, but left it, however, doubtful whether an essential participation in this morbid process belongs to them. Hueter (45) observed

(38.) Buhl: Zeitschrift für Biologie, VI. 129.

(39.) Waldeyer: Virchow's Archiv. LII. 341.

(40.) Wahl: Virchow's Arch. XXI. 579.

(41.) Recklinghausen: Virchow's Arch. XXX., 366.

(42.) Davaine seems to have given no attention to the affections to the alimentary canal in the gangrene of the spleen, at least I find them never mentioned.

(43.) The only chemical analysis of the blood of gangrene of the spleen known to me, Sarcharjin: Virchow's Archiv. XXI. 359, contains only the percentage of the red corpuscles of the blood and the plasma. The first were found diminished by one-third, the latter increased the same amount.

(44.) Buhl: Einiges über Diphtherie, Zeitschrift. für Biologie. III. 341.

(45.) Hüter, Pilzsporen in den Geweben und im Blute bei Gangraena diphtheritica.—Centralblatt VI. 1868, p. 177.

the very same organisms in the grey diphtheritic layers of wounds, and on more careful investigation he found them also in the neighboring tissues, seemingly quite healthy yet. He likewise proved their presence in the blood of such patients. Later, Hueter and Tomsasi (46) observed the same organisms also in the pseudomembranes of diphtheria of the larnyx and pharynx, and in every case in countless numbers in the blood of the patients. By inoculation of the pseudomembranes into the trachea, and beneath the integument at different points of the body, they always again obtained the diphtheritic process ; in such cases they always found countless numbers of the small organisms in the neighborhood of the diseased parts, in tissues apparently quite healthy, as well as in the blood of the inoculated animals. They described them as very small round, or short oval dark colored bodies, all engaged in active motion, entirely of the appearance of Monas crepusculum.

From their experiments of inoculation they drew the conclusion that the virus of diphtheria is probably connected with the organisms.

Nearly simultaneously Oertel (47) published investigations of the relation of these organisms to the diphtheritic process. He observed them in the pseudomembranes, but found also the inflamed mucous membrane filled with these organisms ; further, he could find them in the different lymphatic vessels of the nearest lymphatic glands,in the glands themselves, as well as in the blood-vessels of the kidneys, and other internal organs. According to these discoveries, he re-

(46.) Hüter und Tomasi : Ueber diphteritis. Bayersch, ärztl. Intellig. Blatt. 1868. No. 31.

(47.) Oertel: Studien über diphtheritis. Bayersch, ärztl. Intellig. Blatt. 1868. No. 31.

garded himself justified to bring them in a causal connection with the diphtheritic process.

Nassiloff (48) corroborated the entirely regular appearance of these organisms in the diphtheritic membranes, and sought to discover, by way of experiments, their importance in the morbid process. By inoculations into the cornea, *a multiplication en masse of these organisms appeared regularly as first change at the point of inoculation*, which had filled all the secreting chanels, and even expanded them in part. In the neighborhood of this part of the cornea, filled with parasites, the secreting chanels appeared filled with masses of pus cells. Also, in other localities (in the gums), he could convince himself of the entrance of these organisms into the secreting chanels and lymphatic vessels in the neighborhood of the diphtheritic points; he found them in great numbers, even in the cartilages and bones. From his investigations he draws the conclusion, *that the development of the little organisms represents the primary stage of the diphtheritic process.*

In another larger work, on diphtheria, Oertel (49) establishes the proof by numerous experiments of inoculation, that the morbid process is at first only local at the point of inoculation, and from this point a general infection is first developed. The destruction of tissues, peculiar to the diphtheritic process is caused by the vegetation of those small vegetable or-

(48.) Nassiloff: Ueber die Diphtheritis. Virch. Arch. p. 550.

(49.) Oertel: Experimentelle Untersuchungen über Diphtherie. Deutsch, Arch. f. Klin. Med. VIII. 242.

(50.) The works of Letzerichs: "Zur Kentniss der Diphtheritis" Virchow's Arch. XLV. 327. XLVI. 229, XLVII., 516, differing entirely from the above, can not be considered here, since he establishes the parasitic nature of Diphtheritis solely on the appearance of fungi-strings and spores in the detached pseudomembranes, without having

ganisms, which, during the height of the disease, are destributed in immense numbers through the system, especially in the blood, frequently exceeding six times the number of red corpuscles. He regards them, therefore, *as identical with the contagium.*

As much now as the exact investigations of Hueter, Oertel and Nasiloff make probable the participation of the vegetable organisms, described by them coincidingly, in the diphtheritic process, as much also, as the art of infection, and the development of the entire disease from it, is favorable to the acceptation of the view, that the cause of the disease is identical with the infecting material ; yet, none of the named experimenters has demonstrated by investigation, that really only the vegetable organisms, and not other dissolved solid parts of the diphtheritic membranes are the carriers of the infecting material. (50.)

Of the remaining *infectious diseases* little positive is known, which belongs to the question here under discussion. The most distinct species of organisms have been found in the contents of the alimentary canal and dejections in Asiatic cholera, and described as specific causes of disease. But of how little value

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made anatomical investigations of the diseased mucous membranes. Not every hyphe or spore which is found in the dead tissues, can, without further proof, be regarded as cause of the morbid process, especially if we consider how easily the spores of distinct mould fungi, suspended everywhere in the atmosphere, can get to these points and germinate. Just as little is proved, as already remarked by Oertel, (I. C., 245,) by Letzerich experiment to convey the spores obtained by culture of his diphtheritic fungus to the mucous membranes of animals, since the pathological processes produced in the vagina or conjunctiva of his experiment animal can not be identified with diphtheria. From the botanical description of his diphtheritic fungus, and his drawings of the same, everyone, who knows anything of the morphology of the fungi, must draw the conclusion that Letzerich has no fructificating fungus at all.

these statements are, is seen by comparing the results of the individual investigators with one another.

Already, in the second cholera pandemic in Europe, the "Choleraphyton" has been described in England as the real cause of the disease, which, however, on careful investigation by experts, proved to be eggs of ascarides. In the third pandemic the "Choleraphyton" was again discovered in Germany (1866), but this time also again recognized as innocent eggs of ascarides. Such is also the case of the fungi observed in connection with it.

The Cylindrotœnium cholera Asiatica proved to be Oidium lactis, a mould fungus, appearing almost constantly on sour milk, whilst Hallier obtained from the cholera dejections by culture Pennicillium glaucum, one of the most extensive mould fungi of the world. Nevertheless the course, the mode of distribution, and the art of infection of Asiatic cholera present very many points which irresistably indicate low organisms as the cause of the disease.

The same is true in regard to statements made of other infectious diseases. The sensational discoveries of Salisbury of the etiology of the intermittents, according to which microscopic alges, belonging to the Palmellen, should be the carriers of the miasm, have not been confirmed. Wood (51) even proved from Salisbury's own preparations, that he had taken all kind of defilement and accidental additions as fungi.

If now, in conclusion, we review, once more, the stated investigations, we must, at all events admit that in general they have produced very little that is positive concerning the important, as well as interesting

(51.) Comp. das Referat von Waldeyer in Virchow-Hirsch, Bericht über die Leistungen in der ges. Medecin in Jahr. 1868. I. 206.

question of the nature of the causes of the infectious diseases. At all events their results serve, however, as an essential support to the zymotic theory of the infectious diseases, which was at first based on very indefinite ideas of the fermenting processes, and on their entirely vague analogy with these morbid processes, and, although it has not been entirely proved by them, it has, however, been rendered highly probable. We are, therefore, as yet far from the final decision of the question pertaining to the nature of the contagion, and it yet requires many earnest and patient laborers in this field.

Sammlung Klinisher Vortræge in Verbindung mit deutschen Klinikern. Herausgegeben von Richard Volkmann.

ERRATA.

Page 15, seventh line from the bottom, for "regulation," read "vegetation."